Selection Statement
for the
Space Launch System
Advanced Development
NASA Research Announcement (NRA)
Solicitation Number NNM12ZPS002N

On September 6, 2012, I, along with other senior officials of NASA's Marshall Space Flight Center (MSFC), met with the evaluation team appointed to evaluate proposals in connection with the Space Launch System (SLS) Advanced Development NASA Research Announcement (NRA).

I. PROCUREMENT HISTORY

The purpose of this NRA is to support an evolutionary development strategy for SLS that allows for incremental progress within constrained budgets through the solicitation of innovative development concepts from both industry and academic institutions that improve affordability, reliability, or performance in several key topic areas (Concept Development, Trades, and Analyses; Propulsion; Manufacturing, Structures, and Materials; and Avionics and Software).

This SLS Advanced Development NRA was released on March 20, 2012. On May 15, 2012, eighty-nine proposals were received from the following fifty-eight companies and academic institutions:

ACTA, Inc.	Reynolds Systems, Inc.
Aerojet	Science Applications International Corp. (SAIC)
Alpha Technology, Inc.	Schafer Corp.
Analytical Mechanics Associates, Inc.	Sierra Lobo, Inc.
Ares Corp.	SpaceWorks Enterprises, Inc.
ATA Engineering, Inc.	Streamline Numerics, Inc.
ATK Space Systems, Inc.	Teledyne Brown Engineering, Inc.
Ball Aerospace & Technologies Corp.	The Boeing Company
Bangham Engineering, Inc.	The Charles Stark Draper Laboratory, Inc.
Booz Allen Hamilton, Inc.	United Launch Alliance
CSA Engineering, Inc.	Valcor Engineering Corp.
CFD Research Corp.	ValveTech, Inc.
Collier Research and Development Corp.	WASK Engineering, Inc.
DMS Technology, Inc.	XCOR Aerospace, Inc.
Dynamic Concepts, Inc.	Auburn University
Exquadrum, Inc.	Georgia Tech Research Corp.
Florida Turbine Technologies, Inc.	Iowa State University
Georgia Tech Research Institute	Louisiana State University and A&M College
Honeywell International, Inc.	Massachusetts Institute of Technology (MIT)
JOOIL Metalcasting Institute	Milwaukee School of Engineering
Lockheed Martin Corp.	Mississippi State University
MOOG, Inc. Space and Defense Group	University of Michigan
National Institute of Aerospace Associates	Pennsylvania State University
Northrop Grumman Systems Corp.	University of Alabama at Birmingham (UAB)

Orbital Technologies Corp. (ORBITEC)	University of Alabama in Huntsville (UAH)
Pioneer Astronautics	University of Florida
PolyOne Corp.	University of Maryland
Pratt & Whitney Rocketdyne, Inc.	University of North Texas
ResearchSouth, Inc.	University of Utah

Eighty-five proposals were determined to be compliant with the SLS Advanced Development NRA and were evaluated. One proposal was received late and therefore, in accordance with the NRA, was evaluated to determine if it offered a significant reduction in cost to the Government or if there were significant technical advantages. Three proposals were duplicates and one proposal was noncompliant; these four proposals were returned to each respective offeror.

The selection is expected to result in multiple awards of firm-fixed-price contracts to industry and grants to academia having a period of performance of 12 months, with the potential for two 1-year options.

II. EVALUATION OF PROPOSALS

The proposals were evaluated in accordance with the terms of the NRA. The evaluation criteria consisted of three factors: (1) Relevance to NASA Objectives, (2) Intrinsic Merit, and (3) Price. All three factors were considered approximately equal in importance.

Under the Relevance to NASA Objectives factor, the evaluation team assessed the extent to which the proposed work effort meets the technical scope of the NRA, including the technical maturity relative to the Space Launch System (SLS) vehicle and how the work effort improves or influences the SLS objectives of affordability, reliability, and performance. Under this factor, each proposal was assessed strengths and/or weaknesses. The strengths and weaknesses were reviewed, consolidated, dispositioned, and then assigned significance as appropriate in accordance with the following:

Significant Strength - An aspect of the proposal that greatly enhances the potential for successful contract performance.

Strength - An aspect of the proposal that will have some positive impact on the successful performance of the contract.

Significant Weakness - A flaw that appreciably increases the risk of unsuccessful contract performance.

Weakness - A flaw in the proposal that increases the risk of unsuccessful contract performance.

Subsequently, a consensus adjectival rating was assigned under this factor in accordance with the following:

Excellent - A thorough, and compelling proposal of exceptional merit that fully responds to the objectives of the NRA as documented by numerous or significant strengths and no significant weaknesses.

Very Good - A competent proposal of high merit that fully responds to the objectives of the NRA, whose strengths fully out-balance any weaknesses and none of those weaknesses constitute fatal flaws.

Good - A competent proposal that represents a credible response to the NRA, whose strengths and weaknesses essentially balances each other.

Fair - A proposal that provides a nominal response to the NRA but whose weaknesses outweigh any strengths.

Poor - A seriously flawed proposal having one or more major weaknesses that constitute fatal flaws.

Under the Intrinsic Merit factor, the management approach and technical approach (all which are further defined in the NRA) as well as the approach to the model contract were assessed. Under this factor, each Advanced Development effort was assessed for strengths and/or weaknesses (defined above). The strengths and weaknesses were reviewed, consolidated, dispositioned, and then assigned significance as appropriate. Subsequently, a consensus adjectival rating (defined above) was assigned.

Under the Price factor, the total price for the proposed work effort was evaluated for reasonableness, completeness, and the extent to which the proposal complied with the expected funding allocations in the NRA. Under this factor, findings were reviewed, consolidated, and dispositioned as appropriate. Subsequently, a consensus level of confidence to successfully perform at the proposed price was assigned to each proposed work effort. The level of confidence was expressed as "High," "Medium," or "Low" in accordance with the following:

High - The Government has a very high level of confidence that the offeror can perform successfully at or below the proposed price.

Medium - The Government has a reasonable level of confidence that the offeror can perform successfully at or below the proposed price.

Low - The Government has a marginal level of confidence that the offeror can perform successfully at or below the proposed price.

As indicated, eight-nine proposals were submitted for evaluation. The following is a summary of the Advanced Development efforts selected for negotiation. The Advanced Development industry efforts are presented in alphabetical order, followed by the Advanced Development academic efforts which are also presented in alphabetical order.

INDUSTRY PROPOSALS SELECTED FOR NEGOTIATION

ATA Engineering, Inc.
Development of a Fluid-Structure Interaction Methodology for Predicting Engine Loads

Under the Relevance to NASA Objectives factor, the proposed effort received an adjectival rating of "Excellent" resulting from one significant strength, two strengths, no significant weaknesses, and no weaknesses. The significant strength related to a higher fidelity design to enable reduced engine development costs. The strengths related to (1) analytical tool maturity and the capability to support the SLS vehicle, and (2) improved engine system definition to enable weight reductions.

Under the Intrinsic Merit factor, the proposed effort received an adjectival rating of "Very Good" resulting from no significant strengths, five strengths, no significant weaknesses, and one weakness. The strengths related to (1) past performance, (2) an effective teaming arrangement, (3) an effective technical approach that enables expedient solutions to engine system interaction problems, (4) an early and effective risk mitigation strategy, and (5) extensive relevant work experience. The weakness related to inadequately addressing the assistance needed from Marshall Space Flight Center (MSFC).

Under the Price factor, the proposed effort received a price confidence rating of "High."

ATK Space Systems, Inc.
Affordable Composite Structures

Under the Relevance to NASA Objectives factor, the proposed effort received an adjectival rating of "Excellent" resulting from one significant strength, one strength, no significant weaknesses, and no weaknesses. The significant strength related to the advancement of relevant and critical technology to a maturity level capable of supporting the SLS vehicle. The strength related to utilizing proven manufacturing techniques to lower cost and increase reliability.

Under the Intrinsic Merit factor, the proposed effort received an adjectival rating of "Very Good" resulting from no significant strengths, six strengths, no significant weaknesses, and five weaknesses. The strengths related to (1) a state of the art facility with extensive capabilities, (2) an effective plan and methodology for technology and design development through concept comparisons, (3) an effective technical approach for mitigating hardware handling and storage issues, (4) utilization of proven and mature processes for manufacturing composite structures, (5) clear demonstration of an understanding of the present state of knowledge and how the work effort utilizes innovation, and (6) leveraging extensive experience in materials and manufacturing. The weaknesses related to (1) inadequately addressing the verification and comparison of test and article fabrication, (2) rights in data, (3) inadequate details or Letter of Intent, (4) the schedule, and (5) current and pending support.

Under the Price factor, the proposed effort received a price confidence rating of "Low."

Ball Aerospace & Technologies Corp.
Ball Reliable Advanced Integrated Network (BRAIN)

Under the Relevance to NASA Objectives factor, the proposed effort received an adjectival rating of "Good" resulting from no significant strengths, one strength, no significant weaknesses, and no weaknesses. The strength related to the incorporation of technologies for enabling weight reduction and increased reliability.

Under the Intrinsic Merit factor, the proposed effort received an adjectival rating of "Very Good" resulting from one significant strength, four strengths, no significant weaknesses, and three weaknesses. The significant strength related to an effective technical approach for utilizing various modern avionics technologies. The strengths related to (1) past performance, (2) a clear demonstration and understanding of the current state-of-practice and an effective upgrade and implementation approach, (3) an effective approach for integrating innovative and beneficial materials, and (4) leveraging extensive relevant experience in the field of avionics. The weaknesses related to (1) lack of clarity with respect to cost associated with the Letter of Intent, (2) inadequately addressing various processing and validation details for specific materials, and (3) inadequately addressing the maturity, or impacts to the SLS vehicle, of a specific system component.

Under the Price factor, the proposed effort received a price confidence rating of "Medium."

Collier Research and Development Corp.
Affordable Structural Weight Reduction for SLS Block 1A

Under the Relevance to NASA Objectives factor, the proposed effort received an adjectival rating of "Good" resulting from no significant strengths, one strength, no significant weaknesses, and one weakness. The strength related to the use of a mature analytical tool for optimizing vehicle design. The weakness related to inadequately supporting proposed cost metrics.

Under the Intrinsic Merit factor, the proposed effort received an adjectival rating of "Good" resulting from no significant strengths, four strengths, no significant weaknesses, and five weaknesses. The strengths related to (1) leveraging relevant work experience, (2) an effective technical approach for analytical tool validation, (3) utilization of a mature analytical tool to facilitate reliable trade studies, and (4) an effective test approach focused on critical load cases. The weaknesses related to (1) management of the work effort, (2) current and pending support, (3) insufficient technical methodology derived from references, (4) inadequately addressing complexity or design change impacts of tooling, and (5) inadequately addressing impacts of specific load considerations.

Under the Price factor, the proposed effort received a price confidence rating of "Medium."

Exquadrum, Inc.
Affordable Upper Stage Engine (AUSE) Requirements Study with Cost Analysis and Engineering Plan

Under the Relevance to NASA Objectives factor, the proposed effort received an adjectival rating of "Excellent" resulting from one significant strength, two strengths, no significant weaknesses,

and no weaknesses. The significant strength related to utilization of various affordable and innovative technologies for enabling an upper stage engine. The strengths related to (1) risk reduction efforts at a maturity level capable of supporting the SLS vehicle, and (2) a reduction in engine size and development costs.

Under the Intrinsic Merit factor, the proposed effort received an adjectival rating of "Excellent" resulting from one significant strength, six strengths, no significant weaknesses, and three weaknesses. The significant strength related to an innovative technical approach. The strengths related to (1) an effective teaming arrangement, (2) integration of manufacturing and assembly into the design process, (3) past performance, (4) utilization of validated analytical tools to enable mature and reliable engine components, (5) early risk mitigation strategies, and (6) relevant work experience. The weaknesses related to (1) the schedule, (2) inadequate discussion of Statement of Work (SOW) tasks, and (3) insufficient detail and clarity when describing a specific engine component test setup and design.

Under the Price factor, proposed effort received a price confidence rating of "Low."

MOOG, Inc. Space & Defense Group
Space Launch System Program AUSEP LOX Flow Control Valve

Under the Relevance to NASA Objectives factor, the proposed effort received an adjectival rating of "Very Good" resulting from no significant strengths, two strengths, no significant weaknesses, and no weaknesses. The strengths related to (1) applicability of a technology to multiple engine systems capable of supporting the SLS vehicle, and (2) utilization of innovative, low cost manufacturing techniques.

Under the Intrinsic Merit factor, the proposed effort received an adjectival rating of "Very Good" resulting from no significant strengths, seven strengths, no significant weaknesses, and four weaknesses. The strengths related to (1) an effective risk mitigation approach, (2) past performance, (3) an effective approach for comparing manufacturing techniques, (4) generation of critical data for understanding manufacturing techniques, (5) a best practice and effective testing approach, (6) a simple and innovative system design, and (7) extensive relevant work experience. The weaknesses related to (1) exception taken to the data rights clause, (2) milestone payments, (3) inadequately addressing an implementation approach or impacts to other systems, and (4) current and pending support.

Under the Price factor, the proposed effort received a price confidence rating of "Medium."

Northrop Grumman Systems Corp.
System Requirements and Affordability Assessment Study for an Affordable Upper Stage Engine (AUSE)

Under the Relevance to NASA Objectives factor, the proposed effort received an adjectival rating of "Excellent" resulting from one significant strength, two strengths, no significant weaknesses, and no weaknesses. The significant strength related to a multi-faceted approach to lifecycle cost (LCC) drivers. The strengths related to (1) a work effort at a maturity level capable of supporting the SLS vehicle, and (2) reducing failure rates as compared to historic engines.

Under the Intrinsic Merit factor, the proposed effort received an adjectival rating of "Excellent" resulting from two significant strengths, five strengths, no significant weaknesses, and two weaknesses. The significant strengths related to (1) an experienced and diverse team, and (2) leveraging relevant work experience. The strengths related to (1) an effective management approach and understanding of the system-level implementation of components, (2) early identification of risk and development of effective mitigation strategies, (3) established base of capabilities, facilities, and equipment, (4) utilization of a risk-based methodology, and (5) utilization of advanced engine design and analysis tools. The weaknesses related to (1) data delivery and (2) inadequately addressing vehicle-level implementation and impacts.

Under the Price factor, the proposed effort received a price confidence rating of "High."

Orbital Technologies Corp.
Hybrid Precision Casting for Regeneratively-Cooled Thrust Chamber Components

Under the Relevance to NASA Objectives factor, the proposed effort received an adjectival rating of "Good" resulting from no significant strengths, one strength, no significant weaknesses, and no weaknesses. The strength related to reduced manufacturing complexity and setup enabling a reduction in cost.

Under the Intrinsic Merit factor, the proposed effort received an adjectival rating of "Very Good" resulting from no significant strengths, four strengths, no significant weaknesses, and no weaknesses. The strengths related to (1) an extensive and comprehensive set of facilities and capabilities, (2) relevant work experience, (3) an effective and innovative approach for eliminating weld or braze joints, and (4) innovative techniques for manufacturing precision parts.

Under the Price factor the proposed effort received a price confidence rating of "High."

Pratt & Whitney Rocketdyne, Inc.
Requirements, Logistics, and System Assessment of an Affordable Upper Stage Engine (AUSE)

Under the Relevance to NASA Objectives factor, the proposed effort received an adjectival rating of "Excellent" resulting from one significant strength, one strength, no significant weaknesses, and no weaknesses. The significant strength related to the thorough survey of available engines and the assessment and optimization of program requirements to enable a concept capable of supporting the SLS vehicle. The strength related to an approach for effectively assessing engine requirements and impacts to cost.

Under the Intrinsic Merit factor, the proposed effort received an adjectival rating of "Excellent" resulting from one significant strength, three strengths, no significant weaknesses, and three weaknesses. The significant strength related to the use of an established suite of systems engineering and analytical tools that have been flight-validated. The strengths related to (1) past performance, (2) a plan to complete a fully open engine assessment that is independent of any assumed constraints or preferred engine configurations, and (3) extensive relevant work experience. The weaknesses related to (1) data delivery, (2) potential sale of the prime contractor, and (3) the schedule.

Under the Price factor the proposed effort received a price confidence rating of "Medium."

Reynolds Systems, Inc.
Advanced Ordnance Systems Demonstration

Under the Relevance to NASA Objectives factor, the proposed effort received an adjectival rating of "Excellent" resulting from one significant strength, one strength, no significant weaknesses, and no weaknesses. The significant strength related to an innovative ordnance concept that reduces system complexity as well as streamlines and simplifies launch operations. The strength related to the use of proven and fielded ordnance technology capable of supporting the SLS vehicle.

Under the Intrinsic Merit factor, the proposed effort received an adjectival rating of "Excellent" resulting from one significant strength, four strengths, no significant weaknesses, and one weakness. The significant strength related to an extensive and knowledgeable technical approach specific to launch systems. The strengths related to (1) an effective teaming arrangement, (2) a concept and system design that greatly enhances safety and assurance, (3) extensive relevant work experience, and (4) an approach utilizing highly innovative technologies and demonstrating state-of-the-art concepts. The weakness related to rights in data.

Under the Price factor the proposed effort received a price confidence rating of "Medium."

Sierra Lobo, Inc.
Cryo-Tracker® Mass Gauging System

Under the Relevance to NASA Objectives factor, the proposed effort received an adjectival rating of "Very Good" resulting from no significant strengths, two strengths, no significant weaknesses, and no weaknesses. The strengths related to (1) a mature concept capable of supporting the SLS vehicle and (2) an ability to reduce launch operation costs and enhance propellant monitoring capabilities.

Under the Intrinsic Merit factor, the proposed effort received an adjectival rating of "Very Good" resulting from no significant strengths, four strengths, no significant weaknesses, and no weaknesses. The strengths related to (1) an effective and established base of capabilities, facilities, and equipment, (2) an effective test and integration approach for all components, (3) an innovative and flexible low impact concept that reduces risk, and (4) leveraging relevant work experience.

Under the Price factor the proposed effort received a price confidence rating of "Medium."

Streamline Numerics, Inc.
Efficient High-Fidelity Design and Analysis Tool for Unsteady Flow Physics in Space Propulsion Geometries

Under the Relevance to NASA Objectives factor, the proposed effort received an adjectival rating of "Good" resulting from no significant strengths, one strength, no significant weaknesses, and no weaknesses. The strength related to algorithm enhancements for Loci-STREAM to enable faster and more reliable simulations.

Under the Intrinsic Merit factor, the proposed effort received an adjectival rating of "Good" resulting no significant strengths, two strengths, no significant weaknesses, and three weaknesses. The strengths related to (1) leveraging relevant work experience, and (2) an expansion upon the current state of practice that enables solutions for more complex problems. The weaknesses related to (1) rights in data, (2) proposed testing of software at NASA facilities, and (3) an approach to verify and validate the modified Loci-STREAM code.

Under the Price factor the proposed effort received a price confidence rating of "High."

The Boeing Company
Robust Distributed Sensor Interface Modules (DSIM) for SLS

Under the Relevance to NASA Objectives factor, the proposed effort received an adjectival rating of "Good" resulting from no significant strengths, one strength, no significant weaknesses, and no weaknesses. The strength related to utilizing an innovative material for reducing avionics complexity and power requirements.

Under the Intrinsic Merit factor, the proposed effort received an adjectival rating of "Very Good" resulting from no significant strengths, four strengths, no significant weaknesses, and two weaknesses. The strengths related to (1) past performance, (2) leveraging relevant work experience, (3) an effective risk mitigation and test verification approach, and (4) an innovative and effective approach for integrating and interfacing sensors into an avionics system. The weaknesses related to (1) inclusion of a clause into the model contract, and (2) inadequately addressing data sampling rates.

Under the Price factor, the proposed effort received a price confidence rating of "Medium."

United Launch Alliance
Integrated Vehicle Fluids

Under the Relevance to NASA Objectives factor, the proposed effort received an adjectival rating of "Very Good" resulting from one significant strength, no strengths, no significant weaknesses, and no weaknesses. The significant strength related to maintaining low system peak pressures to reduce complexity and cost while enhancing safety.

Under the Intrinsic Merit factor, the proposed effort received an adjectival rating of "Very Good" resulting from one significant strength, five strengths, one significant weakness, and two weaknesses. The significant strength related to an effective and proven teaming arrangement. The strengths related to (1) enabling standalone processing, (2) utilizing boil-off for power, (3) a mobile and efficient test capability, (4) reducing the number of subsystems, and (5) past performance. The significant weakness related to an exception taken to a clause in the Model Contract. The weaknesses related to (1) utilization of statistical methodologies for flight redesign, and (2) inadequately addressing an integration approach.

Under the Price factor the proposed effort received a price confidence rating of "Medium."

ACADEMIC PROPOSALS SELECTED FOR NEGOTIATION

Auburn University
High Electrical Density Device for Aerospace Applications

Under the Relevance to NASA Objectives factor, the proposed effort received an adjectival rating of "Good" resulting from no significant strengths, one strength, no significant weaknesses, and no weaknesses. The strength related to an energy storage device database for rapid system trades and optimization.

Under the Intrinsic Merit factor, the proposed effort received an adjectival rating of "Good" resulting from no significant strengths, three strengths, no significant weaknesses, and four weaknesses. The strengths related to (1) past performance, (2) a dynamic and efficient database to extend the current state-of-knowledge, and (3) extensive experience in material research for electrical energy storage devices. The weaknesses related to (1) model grant, (2) the time commitment of the principle investigator, (3) providing an incomplete experimental methodology, and (4) current and pending support.

Under the Price factor, the proposed effort received a price confidence rating of "Medium."

Louisiana State University and A&M College
Challenges Towards Improved Friction-Stir-Welds Using On-line Sensing of Weld Quality

Under the Relevance to NASA Objectives factor, the proposed effort received an adjectival rating of "Very Good" resulting from no significant strengths, one strength, no significant weaknesses, and no weaknesses. The strength related to correlating weld defects to process control parameters and improving weld defect detection and prediction.

Under the Intrinsic Merit factor, the proposed effort received an adjectival rating of "Excellent" resulting from one significant strength, six strengths, no significant weaknesses, and four weaknesses. The significant strength related to an understanding of the present state of knowledge shown through an effective and thorough technical approach. The strengths related to (1) management and planning, (2) extensive, working facilities knowledge and access through pre-existing relationships, (3) extensive internal capabilities and infrastructure, (4) an innovative and efficient visual real-time weld assessment method, (5) an environmentally friendly treatment process for weld improvement, and (6) utilizing mature technologies for innovative applications. The weaknesses related to (1) task leaders and continuity, (2) coordination and approval for use of a government facility, (3) inadequately addressing weld tool interactions, and (4) inadequately addressing data acquisition.

Under the Price factor, the proposed effort received a price confidence rating of "Medium."

Massachusetts Institute of Technology
A New Modeling Approach for Rotating Cavitation Instabilities in Rocket Engine Turbopumps

Under the Relevance to NASA Objectives factor, the proposed effort received an adjectival rating of "Very Good" resulting from no significant strengths, one strength, no significant weaknesses, and no weaknesses. The strength related to an enhanced and optimized design capability to enable a reduction in operational costs and component fatigue.

Under the Intrinsic Merit factor, the proposed effort received an adjectival rating of "Very Good" resulting from no significant strengths, three strengths, no significant weaknesses, and one weakness. The strengths related to (1) an effective teaming arrangement, (2) extensive facilities, capabilities, and equipment, and (3) an effective modeling approach to enable innovative designs. The weakness related to the model grant.

Under the Price factor, the proposed effort received a price confidence rating of "Medium."

Mississippi State University
Algorithmic Enhancements for High-Resolution Hybrid RANS-LES Using Loci-CHEM

Under the Relevance to NASA Objectives factor, the proposed effort received an adjectival rating of "Very Good" resulting from no significant strengths, one strength, no significant weaknesses, and no weaknesses. The strength related to providing a mature algorithmic enhancement to improve analytical fidelity and capable of supporting the SLS vehicle.

Under the Intrinsic Merit factor, the proposed effort received an adjectival rating of "Excellent" resulting from one significant strength, four strengths, no significant weaknesses, and one weakness. The significant strength related to an innovative extension of the current state-of-the-art to extend the validation range of computational fluid dynamics simulation. The strengths related to (1) leveraging high-performance facilities, (2) leveraging critical integration expertise, (3) a low risk and modular development approach, and (4) relevant work experience. The weakness related to time commitments of team members.

Under the Price factor, the proposed effort received a price confidence rating of "Medium."

Mississippi State University
Next Generation Simulation Infrastructure on Large Scale Multicore Architecture

Under the Relevance to NASA Objectives factor, the proposed effort received an adjectival rating of "Good" resulting from no significant strengths, one strength, no significant weaknesses, and no weaknesses. The strength related to enhanced simulation and computer processing capabilities.

Under the Intrinsic Merit factor, the proposed effort received an adjectival rating of "Excellent" resulting from one significant strength, two strengths, no significant weaknesses, and one weakness. The significant strength related to an innovative approach for achieving future computational requirements and utilizing next-generation infrastructure. The strengths related to (1) leveraging

relevant work experience and critical expertise, and (2) an effective incremental technical approach and implementation plan. The weakness related to the model grant and SOW.

Under the Price factor, the proposed effort received a price confidence rating of "Low."

Pennsylvania State University
Characterization of Aluminum/Alumina/Carbon Interactions under Simulated Rocket Motor Conditions

Under the Relevance to NASA Objectives factor, the proposed effort received an adjectival rating of "Very Good" resulting from no significant strengths, one strength, no significant weaknesses, and no weaknesses. The strength related to understanding critical reactions for improving analysis and enabling a reduction in design margins and cost.

Under the Intrinsic Merit factor, the proposed effort received an adjectival rating of "Excellent" resulting from one significant strength, seven strengths, no significant weaknesses, and two weaknesses. The significant strength related to an effective and multi-faceted technical approach for modeling and validation. The strengths related to (1) leveraging previous critical data, (2) extensive on-site capabilities and materials, (3) past performance, (4) delivery of extensive data and results, (5) testing flexibility, (6) relevant work experience and familiarity with equipment, and (7) an effective technical approach for analyzing and validating data. The weaknesses related to (1) milestones and timely deliverables, and (2) inadequately addressing the maturity of a specific analysis and characterization technique.

Under the Price factor, the proposed effort received a price confidence rating of "Medium."

University of Florida
Development of Subcritical Atomization Models in the Loci Framework for Liquid Rocket Injectors

Under the Relevance to NASA Objectives factor, the proposed effort received an adjectival rating of "Good" resulting from no findings and met the expected standard for this factor.

Under the Intrinsic Merit factor, the proposed effort received an adjectival rating of "Very Good" resulting from no significant strengths, three strengths, no significant weaknesses, and no weaknesses. The strengths related to (1) an effective teaming arrangement that leverages critical expertise, (2) extensive relevant work experience, and (3) an innovative and effective approach for performing combustion transient simulations.

Under the Price factor, the proposed effort received a price confidence rating of "Medium."

University of Florida
Determination of Heat Transfer Coefficients for Two-Phase Flows of Cryogenic Propellants During Line Chilldown and Fluid Transport

Under the Relevance to NASA Objectives factor, the proposed effort received an adjectival rating of "Very Good" resulting from no significant strengths, one strength, no significant weaknesses, and no weaknesses. The strength related to generation of accurate heat transfer data to optimize design and reduce system hazards and complexity.

Under the Intrinsic Merit factor, the proposed effort received an adjectival rating of "Good" resulting from no significant strengths, four strengths, no significant weaknesses, and three weaknesses. The strengths related to (1) an effective management approach, (2) generation of relevant data over a wide range of conditions, (3) an innovative and accurate flow measurement technique, and (4) leveraging previous work and capabilities. The weaknesses related to (1) inadequately addressing option year tasks in the SOW, (2) test instrumentation setup, and (3) inadequately addressing the correlation of results to more relevant flight conditions and systems.

Under the Price factor, the proposed effort received a price confidence rating of "Low."

University of Maryland
Validation of Subsonic Film Cooling Numerical Simulations Using Detailed Measurements and Novel Diagnostics

Under the Relevance to NASA Objectives factor, the proposed effort received an adjectival rating of "Good" resulting from no significant strengths, one strength, no significant weaknesses, and no weaknesses. The strength related to an enhanced modeling accuracy and fidelity for film cooling flowfields to reduce testing and improve data reliability.

Under the Intrinsic Merit factor, the proposed effort received an adjectival rating of "Very Good" resulting from no significant strengths, four strengths, no significant weaknesses, and two weaknesses. The strengths related to (1) critical in-house capabilities and facilities, (2) past performance, (3) relevant work experience, and (4) an effective experimental and validation approach. The weaknesses related to (1) inadequately addressing rationale for specific tasks in the SOW, and (2) inadequately addressing the maturity of specific analytical capabilities.

Under the Price factor, the proposed effort received a price confidence rating of "Medium."

University of Maryland
Validation of Supersonic Film Cooling Numerical Simulations Using Detailed Measurements and Novel Diagnostics

Under the Relevance to NASA Objectives factor, the proposed effort received an adjectival rating of "Good" resulting from no significant strengths, one strength, no significant weaknesses, and no weaknesses. The strength related to an enhanced modeling accuracy and fidelity for film cooling flowfields to reduce testing and improve data reliability.

Under the Intrinsic Merit factor, the proposed effort received an adjectival rating of "Very Good" resulting from no significant strengths, four strengths, no significant weaknesses, and one weakness. The strengths related to (1) critical in-house capabilities and facilities, (2) past performance, (3) relevant work experience, and (4) an effective experimental and validation approach. The weakness related to inadequately addressing rationale for specific tasks in the SOW.

Under the Price factor, the proposed effort received a price confidence rating of "Medium."

University of Michigan
Advanced LES and Laser Diagnostics to Model Transient Combustion-Dynamical Processes in Rocket Engines: Prediction of Flame Stabilization and Combustion-Instabilities

Under the Relevance to NASA Objectives factor, the proposed effort received an adjectival rating of "Good" resulting from no significant strengths, one strength, no significant weaknesses, and no weaknesses. The strength related to an increased understanding and analytical capabilities for combustion instability to reduce testing and improve design fidelity.

Under the Intrinsic Merit factor, the proposed effort received an adjectival rating of "Very Good" resulting from no significant strengths, six strengths, no significant weaknesses, and two weakness. The strengths related to (1) an effective teaming arrangement and leveraging critical expertise, (2) effective facilities, capabilities, and equipment, (3) past performance, (4) an innovative and comprehensive technical approach for data at full-scale engine conditions, (5) relevant work experience, and (6) providing a comprehensive database for future validation efforts. The weaknesses related to (1) current and pending support, and (2) schedule and milestones.

Under the Price factor, the proposed effort received a price confidence rating of "Medium."

University of Utah
Acoustic Emission-Based Health Monitoring of Space Launch System Structures

Under the Relevance to NASA Objectives factor, the proposed effort received an adjectival rating of "Good" resulting from no significant strengths, one strength, no significant weaknesses, and no weaknesses. The strength related to an enhanced inspection and handling capability to enable reduced processing costs and improved reliability.

Under the Intrinsic Merit factor, the proposed effort received an adjectival rating of "Very Good" resulting from no significant strengths, four strengths, no significant weaknesses, and two weakness. The strengths related to (1) extensive facilities, capabilities, and equipment, (2) relevant work experience, (3) an innovative approach to sensor distribution and damage detection, and (4) an effective and reliable standard for defining damage. The weaknesses related to (1) teaming commitment and Letter of Intent, and (2) inadequately addressing hardware and sensor processing.

Under the Price factor, the proposed effort received a price confidence rating of "Medium."

III. SELECTION DECISION

During the presentation, I carefully considered the detailed findings of the NRA evaluation team and the team's responses to my questions about those findings. I also solicited and considered the views of key senior personnel who attended the presentation. These key senior personnel have responsibility related to this procurement and understood the application of the evaluation factors set forth in the NRA.

Although I agreed with findings presented by the NRA evaluation team, I also recognized it was my responsibility as the selection official to examine the findings for each proposal and use my independent judgment to determine the appropriate discriminators for purposes of selection. Therefore, after careful consideration of the detailed findings and my interactions with the evaluation team and key senior advisors, I determined that (1) the findings resulted from a thorough and accurate review of the proposals and (2) the adjectival and cost confidence ratings were supported by the underlying findings and therefore accurately reflected the relative standing of the proposals under each of the three evaluation factors (i.e., Relevance to NASA Objectives, Intrinsic Merit, and Price).

Next, I determined that the Advanced Development efforts that represented the best value to the Government received a rating of either "Excellent", "Very Good", or "Good" under both the Relevance to NASA Objectives factor and the Intrinsic Merit factor. Consequently, I eliminated from further consideration all proposals that did not meet this standard. With respect to the Price factor, I considered the reasonableness of the price offered, and also the evaluation team's assessment of price confidence. In particular, I paid close attention to the basis for any price confidence ratings of "Low", to assess the risks for that proposal. Finally, in addition to considering the evaluation team's ratings and recommendations, I considered program priorities, project balance, and available and projected funding to determine which proposals represent the best value to the Government.

Therefore, from the proposals within the range described above, after adjusting for program priorities and balance, and available and projected funding, I selected Advanced Development efforts from the following offerors for negotiation:

ATA Engineering, Inc.	Pratt & Whitney Rocketdyne, Inc.	Massachusetts Institute of Technology
ATK Space Systems, Inc.	Reynolds Systems, Inc.	Mississippi State University
Ball Aerospace & Technologies Corp.	Sierra Lobo, Inc.	Pennsylvania State University
Collier Research and Development Corp.	Streamline Numerics, Inc.	University of Florida
Exquadrum, Inc.	The Boeing Company	University of Maryland
MOOG, Inc. Space and Defense Group	United Launch Alliance	University of Michigan
Northrop Grumman Systems Corp.	Auburn University	University of Utah
Orbital Technologies Corp.	Louisiana State University and A&M College	

These selections are being made to begin negotiations for potential awards. Due to the on-going uncertainty about the Fiscal Year 2013 budget, including the potential for multiple Continuing Resolutions and/or Sequestration, negotiations will be initiated only on those selections that have the highest priority. Priority was determined in consideration of evaluation results, schedule, and potential national advanced development benefits. Negotiations will be initiated on the other selections as the budget for selected advanced development efforts permits. Awards on any of the selections are also dependent on successful negotiations.

Selections for immediate negotiation:

Exquadrum, Inc.	Auburn University	University of Florida
MOOG, Inc. Space and Defense Group	Louisiana State University	University of Maryland
Northrop Grumman Systems Corp.	Massachusetts Institute of Technology	University of Michigan
Pratt & Whitney Rocketdyne, Inc.	Mississippi State University	University of Utah
	Pennsylvania State University	

Selections dependent on budget resolution prior to negotiations:

ATA Engineering, Inc.	Reynolds Systems, Inc.	
ATK Space Systems, Inc.	Sierra Lobo, Inc.	
Ball Aerospace & Technologies Corp.	Streamline Numerics, Inc.	
Collier Research and Development Corp.	The Boeing Company	
Orbital Technologies Corp.	United Launch Alliance	

The following is part of the selection decision rationale of the Advanced Development efforts selected for negotiation. The Advanced Development industry efforts are presented in alphabetical order, followed by the Advanced Development academic efforts which are also presented in alphabetical order.

INDUSTRY PROPOSALS SELECTED FOR NEGOTIATION

ATA Engineering, Inc.
Development of a Fluid-Structure Interaction Methodology for Predicting Engine Loads

ATA Engineering, Inc. received an adjectival rating of "Excellent" under the Relevance to NASA Objectives factor, an adjectival rating of "Very Good" under the Intrinsic Merit factor, and a confidence level of "High" under the Price factor. The proposed price is reasonable for the proposed work. ATA's work will develop a fluid-structure interaction methodology that advances load determination for liquid engine nozzles and enables higher fidelity designs, which could lead to improved engine performance and sizing. Of particular importance is how this method will expedite

solutions to system interaction problems and allow for more comprehensive simulations. This effort could improve affordability by facilitating a reduction in testing costs due to fewer failures and test iterations, which is a critical factor for supporting the SLS development strategy.

ATK Space Systems, Inc.
Affordable Composite Structures

ATK Space Systems, Inc. received an adjectival rating of "Excellent" under the Relevance to NASA Objectives factor, an adjectival rating of "Very Good" under the Intrinsic Merit factor, and a confidence level of "Low" under the Price factor. The "Low" confidence level for Price was based upon issues relating, in part, to conflicting data in the Price section and a lack of price detail. However, the conflicts are relatively minor in amount and should not present a major risk to the completion of the work effort. NASA's intention is to negotiate satisfactory resolution of price issues. Contract award will be contingent upon resolving these issues. ATK's work will develop innovative composite concepts, including non-destructive inspection and structural health monitoring techniques. Of particular importance is the capability to fabricate large composite structures through the use of state-of-the-art facilities and equipment. Also, one noteworthy attribute of the effort is the utilization of composite manufacturing techniques currently employed on commercial aircraft to reduce cost and improve reliability. This effort also improves reliability and performance by incorporating a structural health monitoring system that addresses undetected/unreported composite damage, which will be critical for utilizing composite structures and supporting future design decisions. In addition, cost savings may be realized if this work effort can be synergistically combined during negotiations with the selected work effort submitted by Collier Research and Development Corp.

Ball Aerospace & Technologies Corp.
Ball Reliable Advanced Integrated Network (BRAIN)

Ball Aerospace & Technologies Corp. received an adjectival rating of "Good" under the Relevance to NASA Objectives factor, an adjectival rating of "Very Good" under the Intrinsic Merit factor, and a confidence level of "Medium" under the Price factor. The proposed price is reasonable for the proposed work subject to successful contract negotiation. The task selected for negotiation from Ball Aerospace's proposal will develop a phased array antenna. Of particular importance is that this provides a single solution antenna that allows for sustained high data rate downlink from launch through completion of a mission without the need for ground stations. This greatly reduces system complexity and improves affordability, reliability, and performance. Also, the concept is relatively mature and offers a great opportunity to implement a state-of-the-art component and upgrade the current state-of-practice avionics architecture.

Collier Research and Development Corp.
Affordable Structural Weight Reduction for SLS Block 1A

Collier Research and Development Corp. received an adjectival rating of "Good" under the Relevance to NASA Objectives factor, an adjectival rating of "Good" under the Intrinsic Merit factor, and a confidence level of "Medium" under the Price factor. The proposed price is reasonable for the proposed work subject to successful contract negotiation. Collier Research's work will develop a composite hat-shaped stiffened design, as well as offer a mature and tested software package, for

optimizing the SLS vehicle structures. One key attribute is that the commercial software tool being utilized is highly flexible and can be focused to explore various objectives to optimize a design based upon the expected critical loads for a specific structure. It also has the potential to provide valuable data and facilitate trades relative to performance and cost. Of particular importance is that the approach to develop the innovative composite design focuses on the critical load cases for composite dry structures and demonstrates an efficient methodology for verifying the concept. Advancing composite structures is a vital aspect of the SLS development strategy for improving vehicle affordability, performance, and reliability. In addition, cost savings may be realized if this work effort can be synergistically combined during negotiations with the selected work effort submitted by ATK Space Systems, Inc.

Exquadrum, Inc.
Affordable Upper Stage Engine (AUSE) Requirements Study with Cost Analysis and Engineering Plan

Exquadrum, Inc. received an adjectival rating of "Excellent" under the Relevance to NASA Objectives factor, an adjectival rating of "Excellent" under the Intrinsic Merit factor, and a confidence level of "Low" under the Price factor. The "Low" confidence level for Price was based upon issues relating, in part, to an inconsistency between the price of a specific task and the lack of detail in the SOW for that task. However, that specific task is a portion of the proposal that is not included in the work that has been selected. NASA's intention is to negotiate satisfactory resolution of all price issues. Contract award will be contingent upon resolving any issues. The task selected for negotiation from Exquadrum's proposal will provide an Affordable Upper Stage Engine (AUSE) requirements assessment. Of particular importance is Exquadrum's experience and ability to analyze and assess innovative concepts and technologies, including manufacturing and material technologies, which could potentially be incorporated into the engine system to greatly reduce costs and improve performance. Exquadrum has also shown an understanding of how to integrate manufacturing and assembly early in a system's design process to capture initial manufacturing issues that saves time and cost. This could be a critical and advantageous attribute for completing the requirements assessment and developing an optimal engine solution.

MOOG, Inc. Space & Defense Group
Space Launch System Program AUSEP LOX Flow Control Valve

MOOG, Inc. Space & Defense Group received an adjectival rating of "Very Good" under the Relevance to NASA Objectives factor, an adjectival rating of "Very Good" under the Intrinsic Merit factor, and a confidence level of "Medium" under the Price factor. The proposed price is reasonable for the proposed work subject to successful contract negotiation. MOOG's work will study manufacturing techniques for developing a liquid oxygen variable flow control valve for an upper stage engine. Of particular importance is the parallel development of dual manufacturing techniques, which enables a direct comparison between a low cost advanced manufacturing approach and the traditional manufacturing approach. This will greatly increase our understanding of new manufacturing technology and provide critical data for future engine system decisions. Also, two noteworthy attributes are that MOOG offers an innovative valve design that is considerably less complex and more reliable than previous designs while also conforming to the requirements of multiple engine options. In addition, improved technical content may be realized if the work effort of a proposed MOOG subcontractor can

be negotiated to more specifically focus on an Affordable Upper Stage Engine (AUSE) requirements assessment.

Northrop Grumman Systems Corp.
System Requirements and Affordability Assessment Study for an Affordable Upper Stage Engine (AUSE)

Northrop Grumman Systems Corp. received an adjectival rating of "Excellent" under the Relevance to NASA Objectives factor, an adjectival rating of "Excellent" under the Intrinsic Merit factor, and a confidence level of "High" under the Price factor. The proposed price is reasonable for the proposed work. The task selected for negotiation from Northrop Grumman's proposal will provide an Affordable Upper Stage Engine (AUSE) requirements and affordability assessment. Noteworthy is that Northrop Grumman will be able to leverage extensive related experience from previous upper stage engine efforts to support and validate the analysis and assessments put forth in the current effort. Of particular importance is that Northrop Grumman offers considerable insight and a multi-faceted approach to addressing potential lifecycle cost drivers that will be critical in improving affordability and understanding performance impacts to the entire engine system.

Orbital Technologies Corp.
Hybrid Precision Casting for Regeneratively-Cooled Thrust Chamber Components

Orbital Technologies Corp. (ORBITEC) received an adjectival rating of "Good" under the Relevance to NASA Objectives factor, an adjectival rating of "Very Good" under the Intrinsic Merit factor, and a confidence level of "High" under the Price factor. The proposed price is reasonable for the proposed work. ORBITEC's work will focus on studying various manufacturing techniques particular to upper stage engine components, and specifically develop a hybrid precision casting process for regeneratively-cooled thrust chamber components. Also noteworthy is ORBITEC's approach to eliminate welded and brazed joints for bonding dissimilar metals, which can improve system reliability and performance as well as improve overall mission flexibility. Of particular importance is the overall goal of reducing manufacturing complexity and setup, including a reduction in labor and time, to achieve greater affordability and reduce recurring costs. This will be completed and assessed through a direction comparison of data from engine parts manufactured from traditional methods as well as the proposed advanced methods.

Pratt & Whitney Rocketdyne, Inc.
Requirements, Logistics, and System Assessment of an Affordable Upper Stage Engine (AUSE)

Pratt & Whitney Rocketdyne, Inc. received an adjectival rating of "Excellent" under the Relevance to NASA Objectives factor, an adjectival rating of "Excellent" under the Intrinsic Merit factor and a confidence level of "Medium" under the Price factor. The proposed price is reasonable for the proposed work subject to successful contract negotiation. Pratt & Whitney's work will provide a complete Affordable Upper Stage Engine (AUSE) requirements, logistics, and system assessment. Several important attributes include the completion of a thorough survey of all available engines in the appropriate thrust class and an adjustment and assessment of those engines based on the current program requirements, which will be followed by a comparison to the current state-of-practice available with the RL-10 engine. Of particular importance is the use of an established and flight-validated suite of systems

engineering and analytical tools, which enables an effective and reliable assessment. The study flexibility and independence from any assumed constraints or established engine configurations will provide an optimal engine solution with the best value.

Reynolds Systems, Inc.
Advanced Ordnance Systems Demonstration

Reynolds Systems, Inc. received an adjectival rating of "Excellent" under the Relevance to NASA Objectives factor, an adjectival rating of "Excellent" under the Intrinsic Merit factor, and a confidence level of "Medium" under the Price factor. The proposed price is reasonable for the proposed work subject to successful contract negotiation. Reynolds' work will develop and demonstrate an advanced ordnance system. Noteworthy is the simple design of the system that offers streamlined integration and launch operations. Of particular importance is the ability of the system to greatly improve safety, along with reliability, through the utilization of technology that is immune to stray energy sources, reduces part counts, and is applicable across various vehicle systems. The concept also allows for system status verification to the end item ordnance interface to assure system integrity. All these benefits allow for significant affordability improvements, such as the potential to avoid costly roll backs of the vehicle. Also, it demonstrates a clear understanding of an effective development approach and knowledge of launch vehicle experience and requirements. This effort has the potential to establish a new and innovative ordnance system for the next generation of SLS launch vehicles that represents a great advancement upon the current state-of-practice.

Sierra Lobo, Inc.
Cryo-Tracker® Mass Gauging System

Sierra Lobo, Inc. received an adjectival rating of "Very Good" under the Relevance to NASA Objectives factor, an adjectival rating of "Very Good" under the Intrinsic Merit factor, and a confidence level of "Medium" under the Price factor. The proposed price is reasonable for the proposed work subject to successful contract negotiation. Sierra Lobo's work will develop a mass gauging system for determining real-time propellant mass and flow rate. Of particular importance is its low power consumption and wide operating temperature range, while at the same time directly resolving issues surrounding previously used engine cutoff sensors. It also enables improved performance monitoring and modeling validation while also reducing launch operation costs. The additional data acquired from such a system may also enable substantial design improvements in future vehicle configurations and upgrades.

Streamline Numerics, Inc.
Efficient High-Fidelity Design and Analysis Tool for Unsteady Flow Physics in Space Propulsion Geometries

Streamline Numerics, Inc. received an adjectival rating of "Good" under the Relevance to NASA Objectives factor, an adjectival rating of "Good" under the Intrinsic Merit factor, and a confidence level of "High" under the Price factor. The proposed price is reasonable for the proposed work. Streamline Numerics' work will develop faster and higher fidelity simulation capabilities of unsteady turbulent flows for the Loci-STREAM code. A critical component of this work effort is the extensive experience and expertise of Streamline Numerics with the Loci-STREAM code, and the ability to leverage

previously developed work to mature the proposed effort. Of particular importance is the fact that the Loci enhancement offers a considerable expansion upon the current state-of-practice. By improving the ability and efficiency to calculate unsteady simulations, more reliable and rapid solutions will drive changes much earlier in the design process, and thus save time and therefore cost.

The Boeing Company
Robust Distributed Sensor Interface Modules (DSIM) for SLS

The Boeing Company received an adjectival rating of "Good" under the Relevance to NASA Objectives factor, an adjectival rating of "Very Good" under the Intrinsic Merit factor, and a confidence level of "Medium" under the Price factor. The proposed price is reasonable for the proposed work subject to successful contract negotiation. Boeing's work will develop a distributed sensor interface module for transmitting sensor data to relevant instruments across systems. Noteworthy is the extensive experience and previously developed data that will be leveraged for this work effort, as well as the innovative approach for interfacing the distributed sensors to the SLS computers and avionics architecture. Of particular importance is the use of silicon-germanium (SiGe) electronics, supported by existing SiGe circuit databases, which have been shown to have an extreme tolerance to temperature, and thus greatly reduces the need for and complexity of external thermal management systems. This can greatly improve reliability and performance of the SLS vehicle avionics system.

United Launch Alliance
Integrated Vehicle Fluids

United Launch Alliance (ULA) received an adjectival rating of "Very Good" under the Relevance to NASA Objectives factor, an adjectival rating of "Very Good" under the Intrinsic Merit factor, and a confidence level of "Medium" under the Price factor. The proposed price is reasonable for the proposed work subject to successful contract negotiation. ULA's work will develop a heat exchanger and cooling system to support the utilization of an integrated vehicle fluids system as an auxiliary power unit. A noteworthy consideration was the extensive experience and effort that was previously put into this system between ULA and its partner, which has been proven to be a very effective teaming arrangement. Of particular importance in this effort is the utilization of the constant boil-off of gaseous hydrogen and oxygen for power generation, while at the same time maintaining low peak pressures for the system, which greatly reduces complexity through the elimination of numerous subsystems and components. This will also reduce operating costs and greatly improve operating safety, which is always a critical area of focus when developing launch vehicle systems.

ACADEMIC PROPOSALS SELECTED FOR NEGOTIATION

Auburn University
High Electrical Density Device for Aerospace Applications

Auburn University received an adjectival rating of "Good" under the Relevance to NASA Objectives factor, an adjectival rating of "Good" under the Intrinsic Merit factor, and a confidence level of "Medium" under the Price factor. The proposed price is reasonable for the proposed work subject to

successful contract negotiation. Auburn University's work will develop an energy storage device database, as well as test the most SLS applicable devices in relevant aerospace environments. One noteworthy attribute is that the effort provides a database that effectively extends the current state-of-knowledge and is conducive to maintaining a "living", dynamic document easily capable of expanding as next generation technologies emerge. Of particular importance is the offering of extensive information that can be utilized as an effective tool for rapidly trading device options for optimizing system designs, which will lead to higher performance systems and improve affordability.

Louisiana State University and A&M College
Challenges Towards Improved Friction-Stir-Welds Using On-line Sensing of Weld Quality

Louisiana State University and A&M College (LSU) received an adjectival rating of "Very Good" under the Relevance to NASA Objectives factor, an adjectival rating of "Excellent" under the Intrinsic Merit factor, and a confidence level of "Medium" under the Price factor. The proposed price is reasonable for the proposed work subject to successful contract negotiation. LSU's work will develop in-process and post-process methods and non-destructive evaluation techniques to improve the prediction of friction-stir weld defects and overall joint quality. Of particular importance is the thoroughness and clear understanding of the present state-of-knowledge to enable the best possible approach for assessing all critical factors and variables. Key attributes include the development of a visual real-time method for immediate assessment of weld quality, which will reduce inspection time, cost, and improve confidence and assurance in the weld; and the use of an environmentally friendly surface treatment process to improve corrosion resistance and improve surface stress and defects, which will also improve weld quality and promote safety. Advancing various manufacturing techniques, including friction-stir welding, will have cost and performance benefits for the next generation of SLS launch vehicles.

Massachusetts Institute of Technology
A New Modeling Approach for Rotating Cavitation Instabilities in Rocket Engine Turbopumps

Massachusetts Institute of Technology (MIT) received an adjectival rating of "Very Good" under the Relevance to NASA Objectives factor, an adjectival rating of "Very Good" under the Intrinsic Merit factor, and a confidence level of "Medium" under the Price factor. The proposed price is reasonable for the proposed work subject to successful contract negotiation. MIT's work will develop an approach for modeling rotating cavitation instabilities in turbopump inducers, as well as explore and develop new inducer and casing treatment designs to mitigate rotating cavitation. Noteworthy is the in-house capability to fabricate new turbomachinery designs, which reduces development time and improves part reliability and traceability. Of particular importance is utilizing a physics-based modeling technique to better understand cavitation phenomena and lead to innovative and higher fidelity designs that mitigate such issues, while also potentially improving performance and reliability by eliminating high cycle fatigue. These results will represent a great advancement in the ability to model cavitation-induced environments in cryogenic engine pumps.

Mississippi State University
Algorithmic Enhancements for High-Resolution Hybrid RANS-LES Using Loci-CHEM

Mississippi State University (MSU) received an adjectival rating of "Very Good" under the Relevance to NASA Objectives factor, an adjectival rating of "Excellent" under the Intrinsic Merit factor, and a confidence level of "Medium" under the Price factor. The proposed price is reasonable for the proposed work subject to successful contract negotiation. MSU's work will develop, implement, and validate multiple analytical methods and turbulence modeling capabilities to enhance the Loci-CHEM code. Noteworthy is the modular approach to implementing the Loci-CHEM upgrades, which will reduce development risk and assure reliable deliverables, and also the ability to easily leverage critical experience and expertise for a reliable integration of the upgrades into the Loci framework. Of particular importance is the innovation behind the upgrades that enables extension of the validation range of computation fluid dynamics simulations for Loci-CHEM, and thus extends the current state-of-the-art. This will result in a much better understanding of the fluid environment and reduce risk in order to improve performance through increased design fidelity.

Mississippi State University
Next Generation Simulation Infrastructure on Large Scale Multicore Architecture

Mississippi State University (MSU) received an adjectival rating of "Good" under the Relevance to NASA Objectives factor, an adjectival rating of "Excellent" under the Intrinsic Merit factor, and a confidence level of "Low" under the Price factor. The "Low" confidence level for Price was based upon issues relating, in part, to a lack of supporting detail in Option Years 1 and 2. NASA's intention is to negotiate satisfactory resolution of the issues relative to the price in the Option Years, and contract award will be contingent upon resolving these issues. MSU's work will upgrade the current Loci framework to enable utilization of multi-core computer processing units and allow for numerous other upgrades to enable higher fidelity simulations. The key attribute of this effort is the overall advancement of the entire Loci framework to best prepare for next generation hardware and facilitate state-of-the-art simulation capabilities. The ability to leverage critical experience and expertise will enable an easy and reliable integration of the necessary upgrades. This work is vital for the continued advancement of computational fluid dynamics capabilities, and it will result in great improvements in design fidelity for increased system performance and reliability. Furthermore, other selected Loci-related proposals will be greatly enhanced if the objectives of this proposal are successful.

Pennsylvania State University
Characterization of Aluminum/Alumina/Carbon Interactions under Simulated Rocket Motor Conditions

Pennsylvania State University (PSU) received an adjectival rating of "Very Good" under the Relevance to NASA Objectives factor, an adjectival rating of "Excellent" under the Intrinsic Merit factor, and a confidence level of "Medium" under the Price factor. The proposed price is reasonable for the proposed work subject to successful contract negotiation. PSU's work will characterize and study aluminum/alumina/carbon reactions that may be active in a solid rocket motor (SRM) environment and on nozzle and insulation materials. Of particular importance is that PSU offers a multi-faceted approach that is highly flexible and effective by utilizing various on-site dynamic testing capabilities to validate the modeling approach for the reactions of interest. The overall approach is very extensive and yields a

comprehensive and valuable data set, and it greatly improves understanding of the SRM reactions over a wide range of operating conditions. This will improve analysis capabilities and allow for smaller design margins and fewer operation anomalies, which will result in greater vehicle performance and reduced costs.

University of Florida
Development of Subcritical Atomization Models in the Loci Framework for Liquid Rocket Injectors

The University of Florida received an adjectival rating of "Good" under the Relevance to NASA Objectives factor, an adjectival rating of "Very Good" under the Intrinsic Merit factor, and a confidence level of "Medium" under the Price factor. The proposed price is reasonable for the proposed work subject to successful contract negotiation. The University of Florida's work will develop subcritical atomization models in unsteady flow conditions for liquid engines to enhance the Loci family of codes. Of particular importance is that it offers an innovative upgrade to the Loci codes that enables the use of computational fluid dynamic (CFD) tools for transient simulations of engine combustion chambers, including the simulation of combustion instabilities, which is something that has yet to be achieved with a CFD tool and would represent an important advancement beyond the current state-of-practice. This new level of modeling fidelity would greatly improve engine system performance and reliability, while also reducing the amount of testing required to improve affordability.

University of Florida
Determination of Heat Transfer Coefficients for Two-Phase Flows of Cryogenic Propellants During Line Chilldown and Fluid Transport

The University of Florida received an adjectival rating of "Very Good" under the Relevance to NASA Objectives factor, an adjectival rating of "Good" under the Intrinsic Merit factor, and a confidence level of "Low" under the Price factor. The "Low" confidence level for Price was based upon issues relating, in part, to inadequate SOW details to validate the price of the effort in Option Years 1 and 2 NASA's intention is to negotiate satisfactory resolution of the price issues in the Option Years;.Contract award for the Option Years will be contingent upon resolving these issues. The University of Florida's work will produce a heat transfer database for the chilldown of fluid transfer lines and other hydraulic components, as well as develop an analytical model based on the database to enhance the available design tools. It is important to note that the effort utilizes an innovative measurement technique capable of delivering accurate and reliable data correlations for heat transfer coefficient. This data is offered over a wide range of conditions and includes laminar and turbulent flow. Of particular importance is that this work will aid in the design of smart control systems to automate the chilldown process, reduce shock, and reduce boiloff; which greatly improves the reliability, affordability, and safety of numerous systems. This advances the current state-of-practice.

University of Maryland
Validation of Subsonic Film Cooling Numerical Simulations Using Detailed Measurements and Novel Diagnostics

The University of Maryland received an adjectival rating of "Good" under the Relevance to NASA Objectives factor, an adjectival rating of "Very Good" under the Intrinsic Merit factor, and a

confidence level of "Medium" under the Price factor. The proposed price is reasonable for the proposed work subject to successful contract negotiation. The University of Maryland's work will develop subsonic film cooling data to validate analytical models for enhancing the Loci-CHEM code. Currently, film cooling data is limited with a certain level of uncertainty, and therefore it would be an important advancement over the current capabilities to enhance the predictive modeling accuracy and fidelity of the Loci-CHEM code for film cooling flow fields. In addition to the improved performance, due to this improved fidelity, it would also drive a reduction in experimental testing and engineering costs to improve affordability. In addition, the subsonic work performed and data acquired in this effort act in conjunction with a second University of Maryland proposal (supersonic data) that is also being selected, and therefore cost savings may be realized if these two work efforts can be synergistically combined more closely during negotiations.

University of Maryland
Validation of Supersonic Film Cooling Numerical Simulations Using Detailed Measurements and Novel Diagnostics

The University of Maryland received an adjectival rating of "Good" under the Relevance to NASA Objectives factor, an adjectival rating of "Very Good" under the Intrinsic Merit factor, and a confidence level of "Medium" under the Price factor. The proposed price is reasonable for the proposed work subject to successful contract negotiation. The University of Maryland's work will develop supersonic film cooling data to validate analytical models for enhancing the Loci-CHEM code. Currently, film cooling data is limited with a certain level of uncertainty, and therefore it would be an important advancement over the current capabilities to enhance the predictive modeling accuracy and fidelity of the Loci-CHEM code for film cooling flow fields. In addition to the improved performance, due to this improved fidelity, it would also drive a reduction in experimental testing and engineering costs to improve affordability. In addition, the supersonic work performed and data acquired in this effort act in conjunction with a second University of Maryland proposal (subsonic data) that is also being selected, and therefore cost savings may be realized if these two work efforts can be synergistically combined more closely during negotiations.

University of Michigan
Advanced LES and Laser Diagnostics to Model Transient Combustion-Dynamical Processes in Rocket Engines: Prediction of Flame Stabilization and Combustion-Instabilities

The University of Michigan received an adjectival rating of "Good" under the Relevance to NASA Objectives factor, an adjectival rating of "Very Good" under the Intrinsic Merit factor, and a confidence level of "Medium" under the Price factor. The proposed price is reasonable for the proposed work subject to successful contract negotiation. The University of Michigan's work will develop an analytical tool to improve modeling accuracy of unstable and combustion-dynamical processes for an enhanced Loci-STREAM code. Noteworthy is that the approach considers a wide range of fuels and provides a comprehensive database, which is currently not available and will be a vital tool for validating future models. Of particular importance is that it enables the computation of complex flame characteristics of injectors while also acquiring numerous types of high fidelity data (e.g. pressure, heat flux, velocity, etc.) at relevant full-scale engine conditions. The ability to acquire full-scale engine data would reduce testing costs and improve affordability for the next generation of vehicles.

University of Utah
Acoustic Emission-Based Health Monitoring of Space Launch System Structures

The University of Utah received an adjectival rating of "Good" under the Relevance to NASA Objectives factor, an adjectival rating of "Very Good" under the Intrinsic Merit factor, and a confidence level of "Medium" under the Price factor. The proposed price is reasonable for the proposed work subject to successful contract negotiation. The University of Utah's work will develop a structural health monitoring system based on an acoustic emission to locate and classify types of impact damage to composite structures. Key attributes of the work effort include the ability to leverage relevant experience and expertise from work performed with the structural health monitoring system of Boeing's 787 aircraft, which will have direct benefits and applications to this proposed work. Also, by the approach focusing on "detectable" rather than "visible" damage, it allows for conservatism to be removed from the design cycle and simplifies the inspection process. Of particular importance is being able to design composite structures to withstand barely detectable damage, which will lower inspection and processing costs, increase their reliability, and make composite structures much more attractive for use on SLS and other future launch vehicles.

The Advanced Development efforts selected for negotiation constituted not only highly rated proposals, but also proposals with the best overall value to the Government when considering program priorities and balance, and available and projected funding. The selected Advanced Development efforts also represent a diverse cross-section of technologies and goals intended to enable competition and engage science, technology, engineering, and mathematics (STEM) education to advance the SLS Block 1A vehicle across all systems and structures. Should negotiations not be successful, programmatic changes occur, or additional funds become available, I may select additional Advanced Development efforts since all proposals remain valid for one year from the proposal submittal date.

Original signed by — *September 20, 2012*

L. Dale Thomas
Associate Director, Technical

Date